MSTB065R039T2RH

N-Channel Silicon Carbide Power MOSFET
650V, 60A, 39mΩ, T2, TOLL

## Product Highlight

Features
- High switching speed with a low gate charge
- Fast intrinsic diode with low reverse recovery
- Robust Avalanche Capability
- 100% Avalanche Tested
- Pb-free, Halogen Free, and RoHS Compliant

Benefits
- System efficiency improvement
- Higher frequency applicability
- Increased power density
- Reduced cooling effort

Applications
- Server & Telecom power
- EV charging station
- Solar inverter / ESS / UPS
- Industrial power supply

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Electronic Symbol

TAB Drain
1 Gate
2 Driver Sourece
3, 4, 5, 6, 7, 8 Power Source
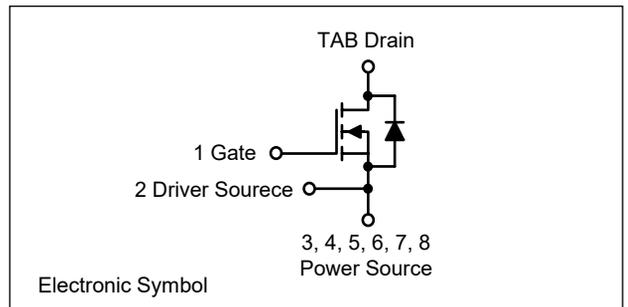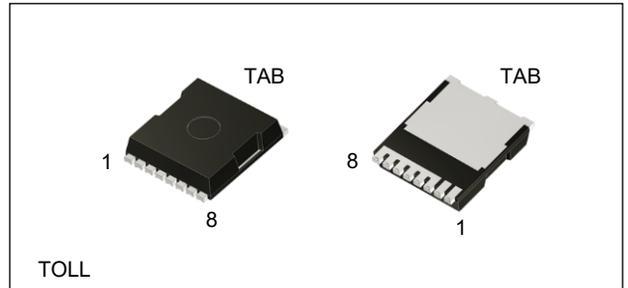
Key Parameters

$BV_{DSS, Tc=25℃}$	$I_{D, Tc=25℃}$	$R_{DS(on),typ}$	$Q_{g,typ}$
650 V	60 A	39 mΩ	60 nC

RoHS Compliant
HALOGEN-FREE

Package Marking and Ordering Information

Part Number	Top Marking	Package	Packing Method	Quantity
MSTB065R039T2RH	065R039T2	TOLL	Tape & Reel	1000 units

Absolute Maximum Ratings (T_C = 25℃ unless otherwise noted)

Symbol	Parameter		Value	Unit
V_{DSS}	Drain to Source Voltage		650	V
V_{GS}	Gate to Source Voltage (DC)		-10 / +22	V
V_{GSop}	Recommended Operation Value		-5 / +18	V
I_D	Drain Current	Continuous (T_C = 25℃)	60*	A
		Continuous (T_C = 100℃)	43*	
I_{DM}	Drain Current	Pulsed (Note1)	161*	A
P_D	Power Dissipation	(T_C = 25℃)	259	W
		Derate Above 25℃	1.72	W/℃
T_J	Operating Temperature Range		-55 to 175	℃

*Limited by maximum junction temperature.
Note 1. Repetitive rating: pulse-width limited by maximum junction temperature.

1. Package

Temperature Ratings

Symbol	Parameter	Value	Unit
T_{STG}	Storage Temperature Range	-55 to 175	℃
T_L	Maximum Lead Temperature for Soldering, 1/8" from Case for 10 Seconds	260	℃

Thermal Characteristics

Symbol	Parameter	Value	Unit
$R_{\theta JC}$	Thermal Resistance, Junction to Case, Max.	0.58	℃/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient, Max.	40	

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2. MOSFET

Electrical Characteristics (T_C = 25℃ unless otherwise noted)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
Off Characteristics						
BV_{DSS}	Drain to Source Breakdown Voltage	V_{GS} = 0 V, I_D = 1 mA	650			V
I_{DSS}	Zero Gate Voltage Drain Current	V_{DS} = 650 V, V_{GS} = 0 V		1	100	μA
		V_{DS} = 650 V, V_{GS} = 0 V, T_J = 175℃		10		
I_{GSS}	Gate-Source Leakage Current	V_{GS} = +22 V, V_{DS} = 0 V			+100	nA
		V_{GS} = -10 V, V_{DS} = 0 V			-100	
On Characteristics						
$V_{GS(th)}$	Gate Threshold Voltage	V_{GS} = V_{DS}, I_D = 10.0 mA (tested after V_{GS} = 22V, 1 ms pulse)	1.8	2.8	4.5	V
$R_{DS(on)}$	Static Drain to Source On Resistance	V_{GS} = 18 V, I_D = 30 A		39	55	mΩ
		V_{GS} = 18 V, I_D = 30 A, T_J = 175℃		52		
g_{fs}	Transconductance	V_{DS} = 20 V, I_D = 30 A		19		S
Dynamic Characteristics						
C_{iss}	Input Capacitance	V_{DS} = 400 V, V_{GS} = 0V, f = 250 kHz		1421		pF
C_{oss}	Output Capacitance			151		
C_{rss}	Reverse Capacitance			7.6		
E_{oss}	Stored Energy in Output Capacitance	V_{DS} = 0 V to 400 V, V_{GS} = 0 V		14.7		μJ
$C_{o(er)}$	Energy Related Output Capacitance			184		pF
$C_{o(tr)}$	Time Related Output Capacitance			261		
$Q_{g(tot)}$	Total Gate Charge	V_{DS} = 400 V, I_D = 30 A, V_{GS} = -5 V / 18 V, Inductive load		60		nC
Q_{gs}	Gate to Source Charge			18		
Q_{gd}	Gate to Drain "Miller" Charge			16		
R_G	Internal Gate Resistance	f = 1MHz		2.5		Ω
Switching Characteristics						
$t_{d(on)}$	Turn-On Delay Time	V_{DS} = 400 V, I_D = 30 A, V_{GS} = -5 V / 18 V, R_G = 5.6 Ω, Inductive load		15.2		ns
t_r	Turn-On Rise Time			12.4		
$t_{d(off)}$	Turn-Off Delay Time			28.7		
t_f	Turn-Off Fall Time			5.3		
E_{on}	Turn-on Switching Energy			40		μJ
E_{off}	Turn-off Switching Energy			49		
E_{tot}	Total Switching Energy			89		

3. Body Diode

Electrical Characteristics (T_C = 25℃ unless otherwise noted)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
Source-Drain Diode Characteristics						
I_S	Maximum Continuous Diode Forward Current			60*		A
I_{SM}	Maximum Pulsed Diode Forward Current			161*		
V_{SD}	Diode Forward Voltage	V_{GS} = -5 V, I_{SD} = 30 A		4.4		V
t_{rr}	Reverse Recovery Time	V_{DD} = 400 V, I_{SD} = 30 A, dI_F/dt = 1000 A/μs, Includes Q_{OSS}		17.8		ns
Q_{rr}	Reverse Recovery Charge			107		nC
I_{rrm}	Peak Reverse Recovery Current			10		A

*Limited by maximum junction temperature.

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4. Typical Performance Characteristics

Figure 1. On-Region Characteristics T_J = -40℃
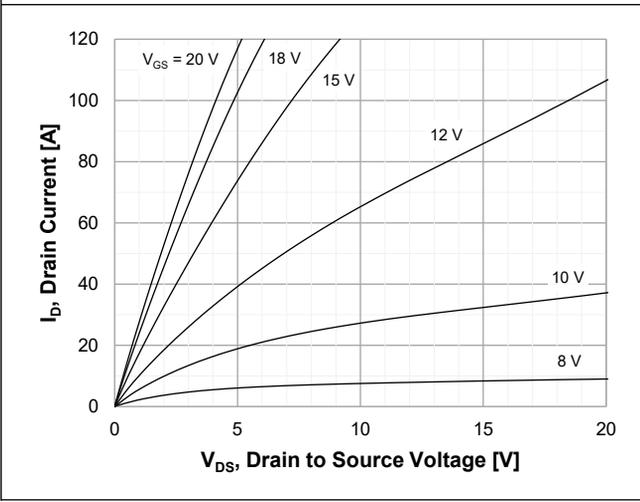
Figure 2. On-Region Characteristics T_J = 25℃
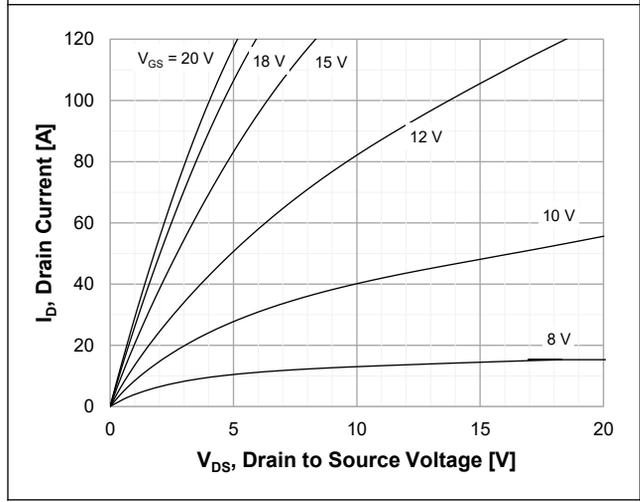
Figure 3. On-Region Characteristics T_J = 125℃
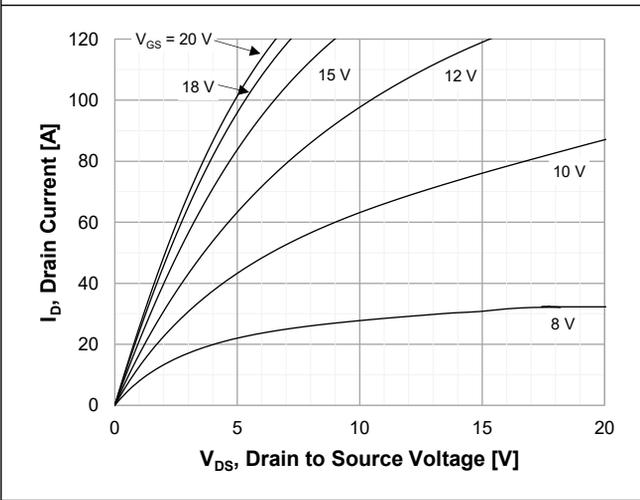
Figure 4. On-Region Characteristics T_J = 175℃
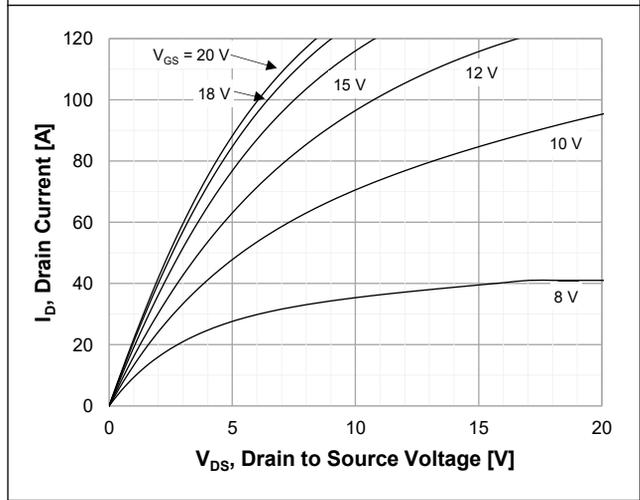
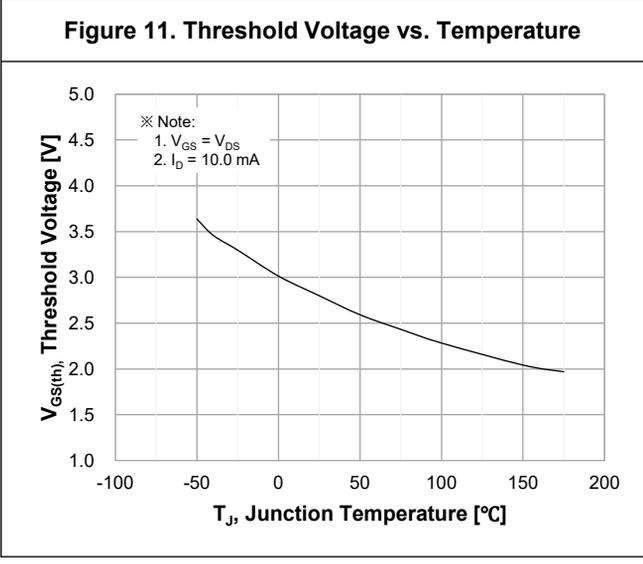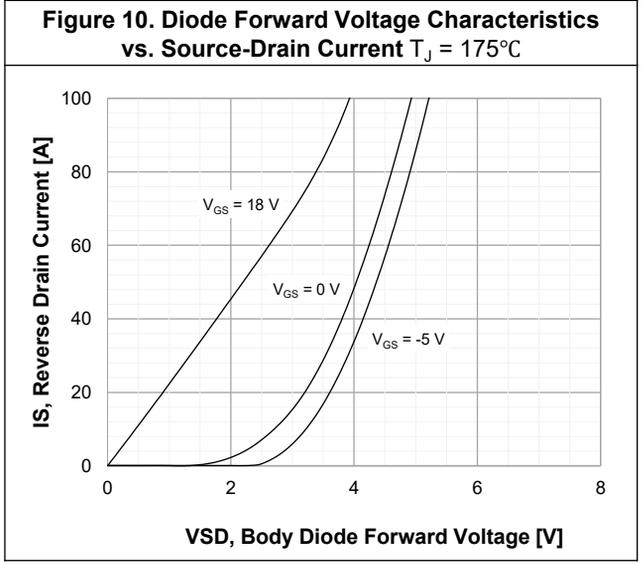

Figure 5. On-Resistance Characteristics vs. Temperature
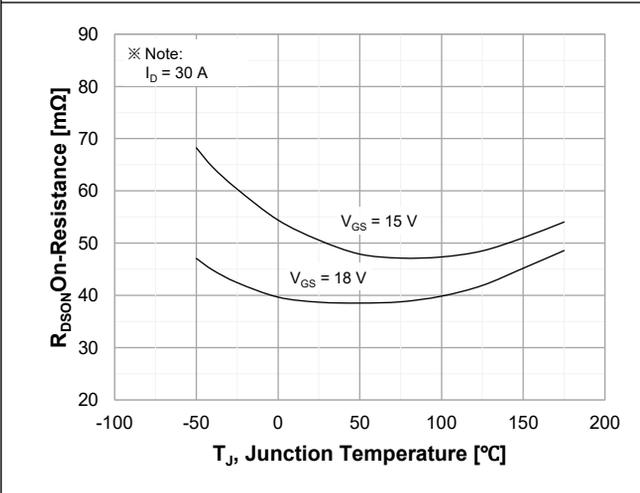
Figure 6. Transfer Characteristics
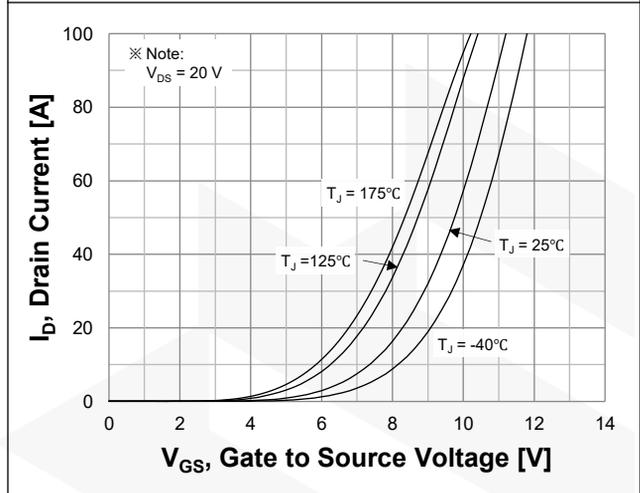
4. Typical Performance Characteristics

Figure 7. Diode Forward Voltage Characteristics vs. Source-Drain Current T_J = -40℃

Figure 8. Diode Forward Voltage Characteristics vs. Source-Drain Current T_J = 25℃

Figure 9. Diode Forward Voltage Characteristics vs. Source-Drain Current T_J = 125℃

Figure 10. Diode Forward Voltage Characteristics vs. Source-Drain Current T_J = 175℃

Figure 11. Threshold Voltage vs. Temperature

Figure 12. Gate Charge Characteristics

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4. Typical Performance Characteristics

Figure 13. Stored Energy in Output Capacitance
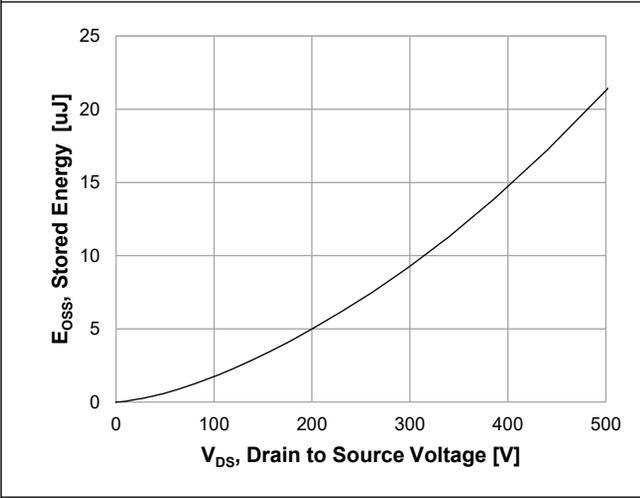
Figure 14. Capacitance Characteristics

※ Note:
1. V_{GS} = 0 V
2. f = 250 kHz

$C_{iss} = C_{gs} + C_{gd}$ (C_{ds} = shorted)
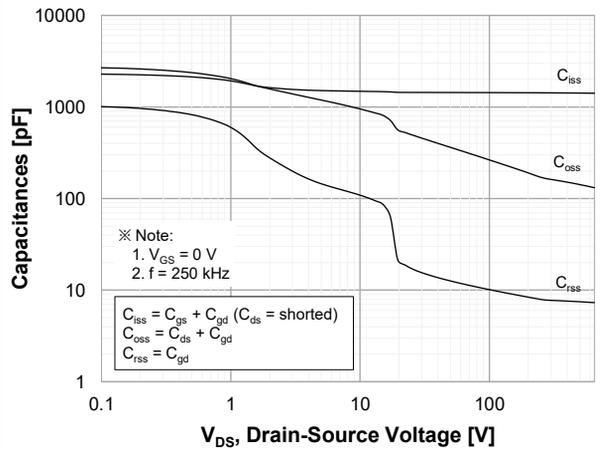$C_{oss} = C_{ds} + C_{gd}$
$C_{rss} = C_{gd}$

Figure 15. Continuous Drain Current Derating vs. Case Temperature
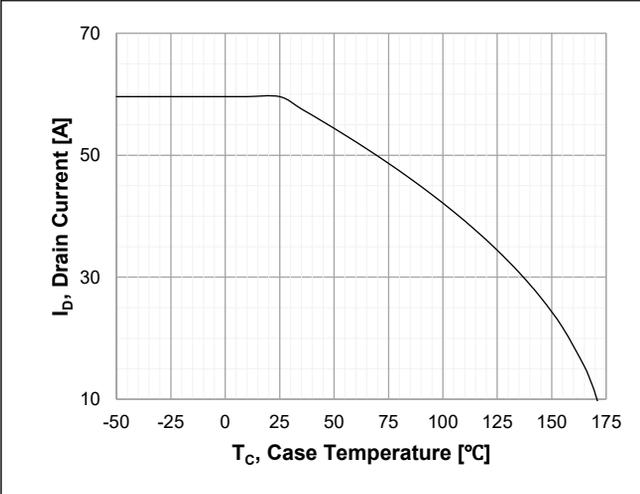
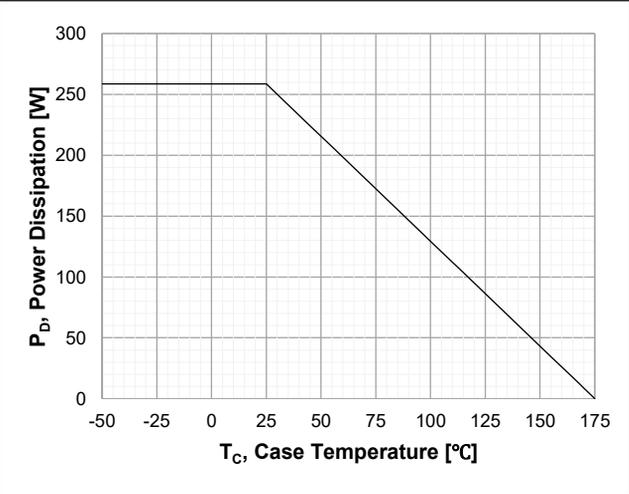### Figure 16. Maximum Power Dissipation Derating vs. Case Temperature
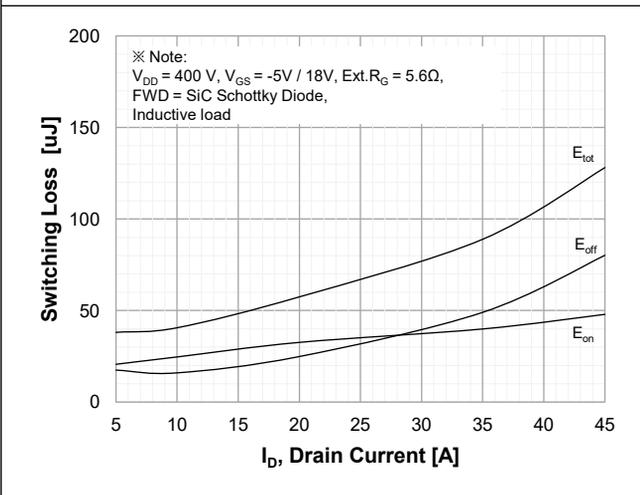

Figure 17. Typ. Switching Losses vs. Drain Current

※ Note:
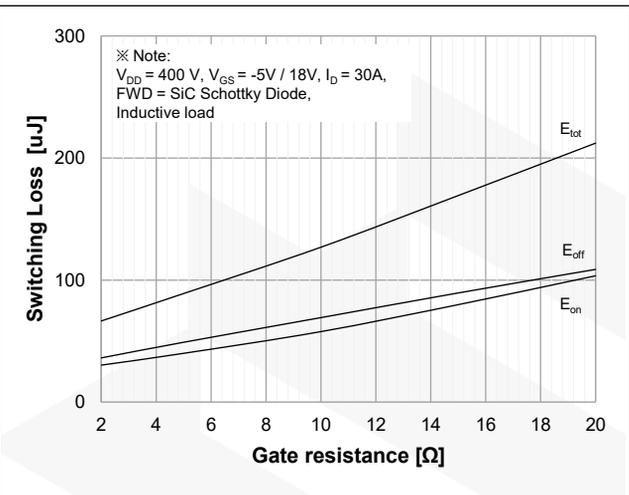V_{DD} = 400 V, V_{GS} = -5V / 18V, Ext.R_G = 5.6Ω,
FWD = SiC Schottky Diode,
Inductive load

Figure 18. Typ. Switching Losses vs. Gate Resistance

※ Note:
V_{DD} = 400 V, V_{GS} = -5V / 18V, I_D = 30A,
FWD = SiC Schottky Diode,
Inductive load

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4. Typical Performance Characteristics

Figure 19. Typ. Switching Losses vs. Drain Current

※ Note:
V_{DD} = 400 V, V_{GS} = -5V / 18V, Ext.R_G = 5.6Ω,
FWD = Same DUT (V_{GS} = -5 V),
Inductive load
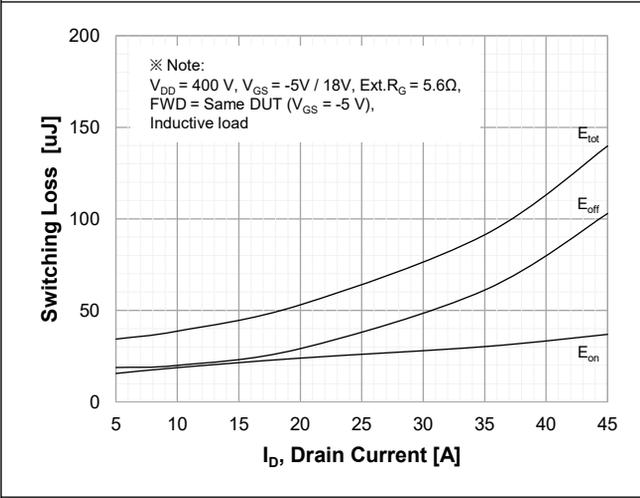
Figure 20. Typ. Switching Losses vs. Gate Resistance

※ Note:
V_{DD} = 400 V, V_{GS} = -5V / 18V, I_D = 30A,
FWD = Same DUT (V_{GS} = -5 V),
Inductive load
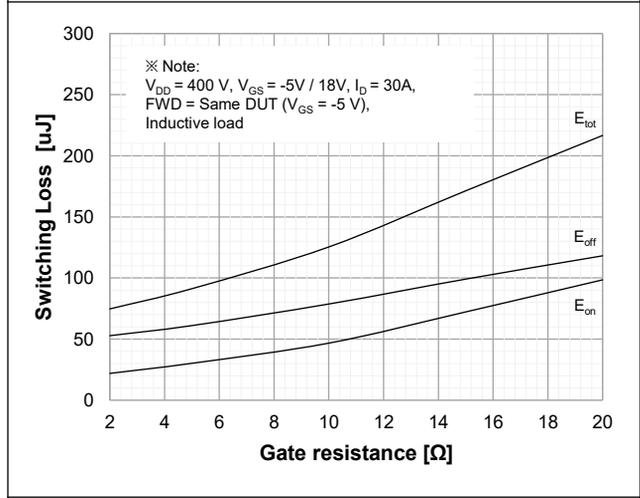
Figure 21. Maximum Safe Operating Area

Operation in this area is limited by $R_{DS(on)}$
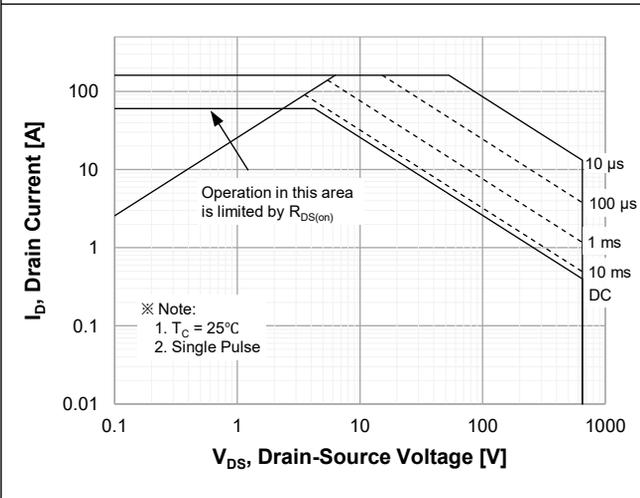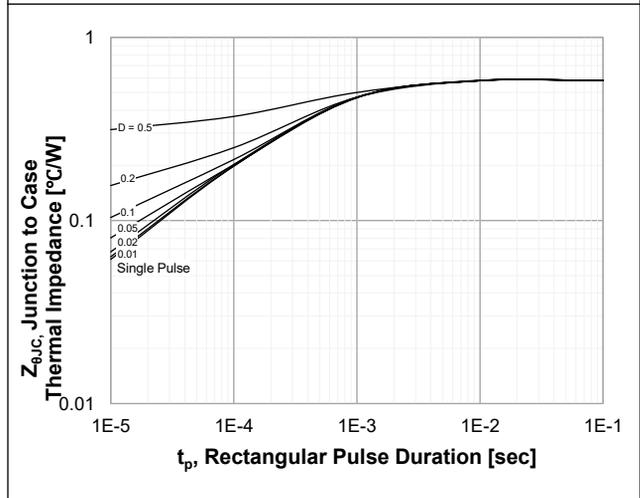
※ Note:
1. T_C = 25℃
2. Single Pulse

Figure 22. Transient Thermal Response Curve

5. Testing conditions

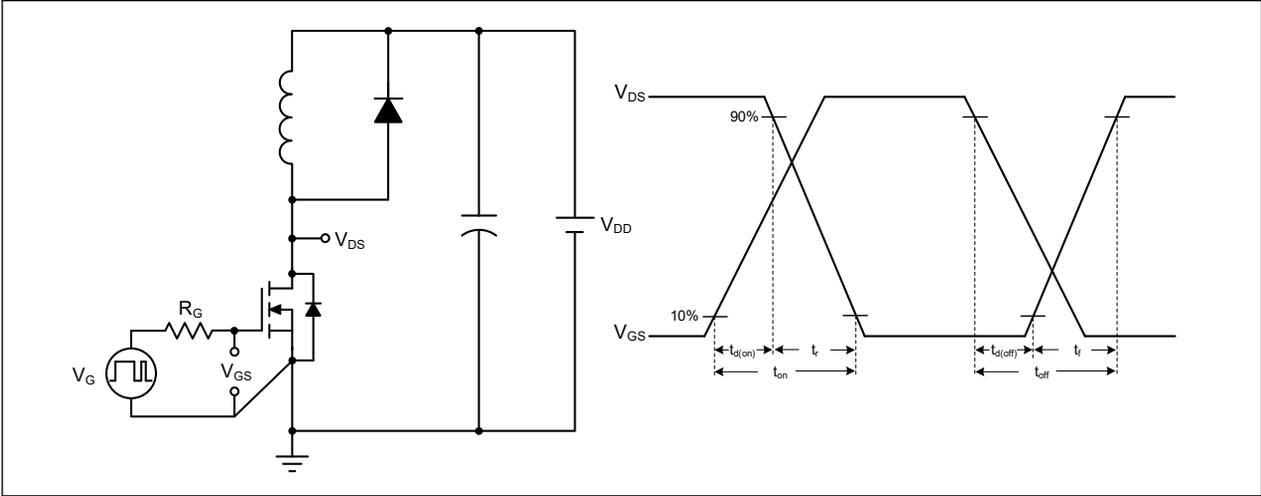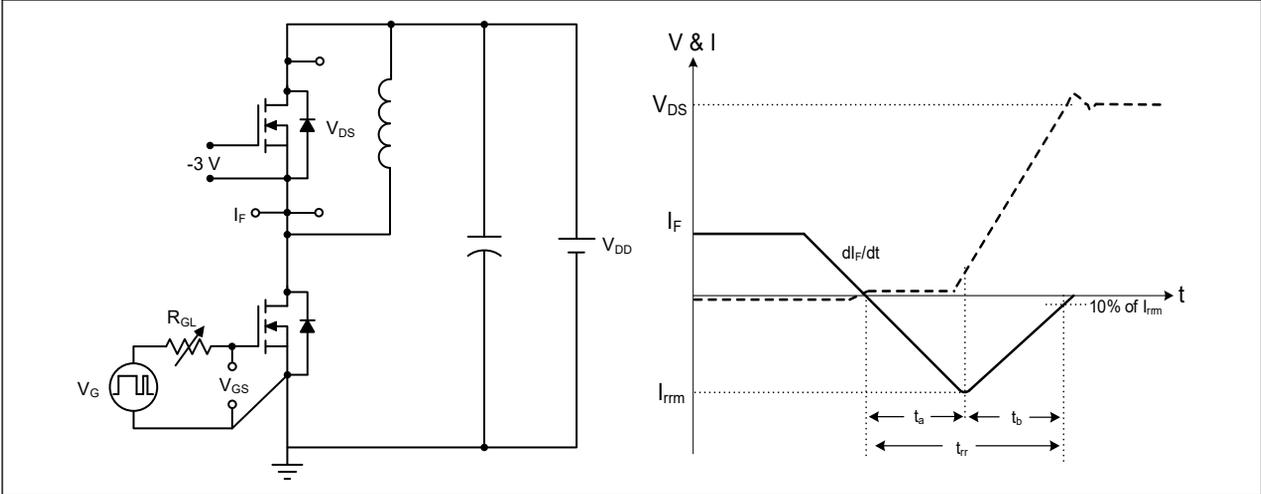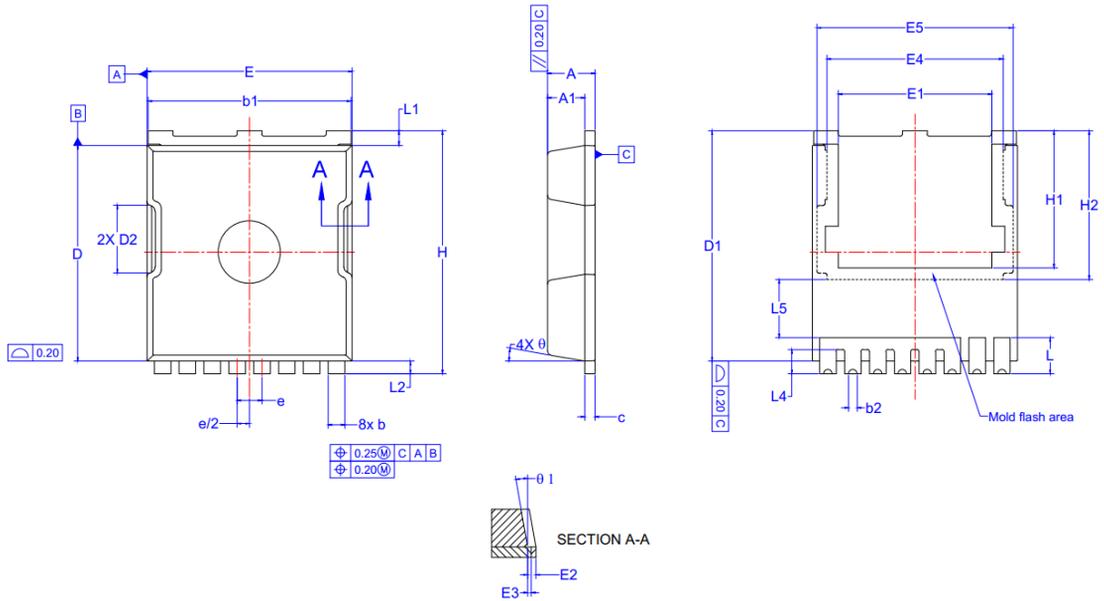### Figure 23. Inductive Load Switching Test Circuit and Waveforms

Figure 24. Peak Diode Recovery dv/dt Test Circuit and Waveforms

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6. Package Outlines – TOLL

* Dimensions in millimeters

SECTION A-A

SYMBOL	MIN.	NOM.	MAX.
A	2.20	2.30	2.40
A1	1.70	1.80	1.90
b	0.70	0.80	0.90
b1	9.70	9.80	9.90
b2	0.36	0.41	0.51
c	0.40	0.50	0.60
D	10.28	10.38	10.48
D1	10.98	11.08	11.18
D2		3.30	
E	9.80	9.90	10.00
E1	7.32	7.42	7.52
E2	0.30	0.40	0.50
E3	0.15	0.18	0.21
E4		8.50	
E5		9.46	
e		1.20 BASIC	
H	11.58	11.68	11.78
H1	6.55	6.65	6.75
H2	7.05	7.15	7.25
L	1.63	1.73	1.83
L1	0.60	0.70	0.80
L2	0.50	0.60	0.70
L4	1.00	1.15	1.30
L5	2.70	2.80	2.90
N		8	
θ		10° REF.	
θ1		10° REF.	

* Dimensions in millimeters